Cosmesis and body image in patients undergoing single-port versus conventional laparoscopic cholecystectomy: a multicenter double-blinded randomized controlled trial (SPOCC-trial)

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Abstract: OBJECTIVE: To evaluate cosmesis, body image, pain, and quality of life (QoL) after single-port laparoscopic cholecystectomy (SPLC) versus conventional 4-port laparoscopic cholecystectomy (4PLC). BACKGROUND: The impact of SPLC on improving cosmesis, body image, pain, and QoL has not been evaluated in double-blinded randomized controlled trials (RCT). This approach therefore remains controversial. METHODS: Between October 2011 and February 2014, 110 patients from 2 centers were randomly assigned to SPLC (n = 55) or 4PLC (n = 55). Primary endpoints were a validated cosmesis (3-24 points) and body image (5-20 points) score after 3 and 12 months. Secondary endpoints included operative duration, postoperative pain, complications, QoL, and length of hospital stay. Patients, physicians, and nurses were blinded until the seventh postoperative day. RESULTS: Demographics were equally distributed between both groups (mean age: 46 years, SD: 14, 62 females, 34 males). The SPLC-group showed superior mean cosmesis and body image compared with the 4PLC-group at 12-weeks (21 vs 16, $P < 0.001$ and 5 vs 6, $P = 0.013$, respectively) and at 1-year (24 vs 16, $P < 0.001$ and 5 vs 6, $P < 0.017$, respectively). Operation duration was longer in the SPLC-group (mean 101 vs 90 minutes, $p = 0.031$). Although postoperative pain was less in the SPLC-group (mean VAS 1 vs 2, $p = 0.005$), there were no differences in complications, and length of hospital-stay. CONCLUSIONS: This is the first multicenter double-blinded RCT reporting superior short- and long-term cosmetic and body image, postoperative pain, and QoL in SPLC compared with 4PLC. Although cost-effectiveness is still a subject of ongoing debate, SPLC should be offered to patients undergoing surgery for benign gallbladder disease.

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Cosmesis and Body Image in Patients Undergoing Single-port Versus Conventional Laparoscopic Cholecystectomy: A Multicenter Double-blinded Randomized Controlled Trial (SPOCC-trial)

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Objective: To evaluate cosmesis, body image, pain, and quality of life (QoL) after single-port laparoscopic cholecystectomy (SPLC) versus conventional 4-port laparoscopic cholecystectomy (4PLC).

Background: The impact of SPLC on improving cosmesis, body image, pain, and QoL has not been evaluated in double-blinded randomized controlled trials (RCT). This approach therefore remains controversial.

Methods: Between October 2011 and February 2014, 110 patients from 2 centers were randomly assigned to SPLC (n = 55) or 4PLC (n = 55). Primary endpoints were a validated cosmesis (3–24 points) and body image (5–20 points) score after 3 and 12 months. Secondary endpoints included operative duration, postoperative pain, complications, QoL, and length of hospital stay. Patients, physicians, and nurses were blinded until the seventh postoperative day.

Results: Demographics were equally distributed between both groups (mean age: 46 years, SD: 14, 62 females, 34 males). The SPLC-group showed superior mean cosmesis and body image compared with the 4PLC-group at 12-weeks (21 vs 16, $P < 0.001$ and 5 vs 6, $P = 0.013$, respectively) and at 1-year (24 vs 16, $P < 0.001$ and 5 vs 6, $P < 0.017$, respectively). Operation duration was longer in the SPLC-group (mean 101 vs 90 minutes, $p = 0.031$). Although postoperative pain was less in the SPLC-group (mean VAS 1 vs 2, $p = 0.005$), there were no differences in complications, and length of hospital-stay.

Conclusions: This is the first multicenter double-blinded RCT reporting superior short- and long-term cosmetic and body image, postoperative pain, and QoL in SPLC compared with 4PLC. Although cost-effectiveness is still a subject of ongoing debate, SPLC should be offered to patients undergoing surgery for benign gallbladder disease.

Keywords: body image, complications, cosmesis, double-blinded, quality of life, randomized controlled trial, single port cholecystectomy

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Gallstone disease constitutes a significant health burden in the western world and its incidence has increased more than 20% over the last 3 decades, affecting 15% of the adult population.[1–3] Even though most patients with gallstones are asymptomatic, 20% will develop biliary colic pain or gallstone complications, such as acute cholecystitis, cholangitis, or pancreatitis.[4] Since Erich Mühe's historic introduction in 1985,[5,6] laparoscopic cholecystectomy (LC) has emerged as the treatment of choice for benign gallbladder disease and has widely replaced conventional open cholecystectomy.[7] In an attempt to further reduce operative trauma and improve cosmetic results after conventional 4-port LC (4PLC), there has been a trend toward minimizing the number of incisions and ports required. As such, new operative techniques, such as single-port laparoscopic cholecystectomy (SPLC),[8] were introduced, using refined versions of existing technology, such as instrumentation that allows greater articulation and rotation, and new retraction systems. Although SPLC is regarded as a safe and "painless" procedure,[9] the cosmetic benefit for the patient remains the main attraction of SPLC.

As highlighted in a recent meta-analysis by the Cochrane Hepato-Biliary Group most of the reported trials today have a flawed trial design and therefore are likely to draw the wrong conclusions. As such, the authors concluded that up to now the overall quality of evidence to support SPLC is low.[9] We therefore designed a multicenter double-blinded randomized controlled (RCT) trial to compare short- and long-term cosmesis and body image, postoperative pain, and quality of life (QoL) in patients undergoing elective SPLC versus 4PLC cholecystectomy for benign gallbladder disease.

METHODS

Trial Design

This multicenter double-blinded randomized clinical trial was conducted to evaluate single-port cholecystectomy (SPLC) versus conventional 4-port cholecystectomy (4PLC) in patients presenting with symptomatic gallbladder disease, operated between October 2011 and February 2014. Superiority of SPLC to 4PLC with regards to cosmesis and body image was hypothesized. The study was conducted according to the principles of the Declaration of Helsinki and reported on the basis of the CONSORT statement.[10] The protocol of the trial was approved by the local ethics commission, registered at clinicaltrials.gov (NCT01278472) and published[11] before enrollment of the first participant.

Sample Size Calculation

A clinically relevant improvement of cosmesis and body image[12] was defined as an improvement of 20% (8 points). Given

the reported standard deviation (SD) between 4 and 6[13] with an alpha of 0.05 and power of 0.90, 2 groups of 49 patients were needed. Taking an estimated 10% dropout rate into consideration, a total of 110 patients were required.[14]

Participants

Eligible participants were German-speaking adults admitted for elective cholecystectomy. Patients with pregnancies, liver cirrhosis, coagulopathy (platelet count below 50,000/μL), double medication on platelet antagonists (acetylsalicylic acid and clopidogrel), or international normalized ratio (INR) above 1.4 were excluded (Fig. 1, CONSORT Flowsheet). Two Swiss centers participated to this trial, the University Hospital Zurich and the Cantonal Hospital Winterthur.

Study Endpoints

The primary endpoint of the trial was the validated cosmesis and body image score at 12 weeks and 1 year. This score was validated in patients undergoing surgery for inflammatory bowel disease[12] and donor nephrectomy.[15] Briefly, the body image score measures the patient's perception of their body and their attitude toward their appearance. This score varies between 5 and 20 points, with a low score meaning a better body image. The assessment of cosmesis was defined as the degree of patient satisfaction with respect to the appearance of their scar(s). A scoring system was used between 3 and 24 points, with a high score meaning a better cosmetic result.[12]

Secondary endpoints included operation duration, postoperative pain (visual analogue scale—VAS), complications (Clavien-Dindo score[16,17] and the comprehensive complication index—CCI[18]), QoL at 12 weeks and 1 year after surgery (short-form-36 health survey questionnaire SF-36[19]), and the length of hospital stay.

Data Collection and Statistical Methods

Informed consent and patient enrolment was carried out in the outpatient clinic. Data included in the patient report forms were collected on an internet-based secured and encrypted data management platform.[20] The cosmesis and body image questionnaire, and the SF-36 QoL questionnaire were completed directly by the patient in the outpatient clinic preoperatively, and 12 weeks and 1 year postoperatively. Pain variables were assessed with a VAS on a daily basis during hospital stay.[11] Patient data were analyzed in the groups to which they were originally randomly assigned (intention-to-treat analysis). Continuous variables were compared with the Student *t* test, the Mann-Whitney *U* test, 1-way ANOVA, and the Kruskal-Wallis H test, where appropriate. Differences among proportions derived from categorical data were compared using the Fisher exact test and the Pearson χ^2 test, where appropriate. All *P* values were 2-sided and considered statistically significant if $P < 0.05$. Statistical analysis was performed on SPSS 22 for Mac (IBM Corp, Armonk, NY).

Randomization

A Web-based patient randomization service for multicenter clinical trials was used (www.randomizer.at).[21] The allocation ratio was 1:1 for both groups. The patients were enrolled to the study by the responsible surgeon at the time of first outpatient clinic visit, and the randomization took place on the operative day during the induction of anesthesia by the responsible surgeon.

Double-blinding

Patients, treating physicians and nurses were blinded until the seventh postoperative day. The skin was closed intracutaneous with a running suture. In addition, the wound was sealed using fibrin glue (Dermabon™; Ethicon Endosurgery Inc, Smithfield, RI) to avoid any blood spots on the dressing. At the end of the operation four 3 M Tegaderm (5 × 7 cm, 3 M Center, St. Paul, MN) occlusive and water-resistant wound dressings were applied at the 4 port-sites (as for 4PLC) in both treatment arms. Dressings were marked with a sterile permanent marker to detect any violation of the blinding. Any suspicion or confirmation of violation of blinding was recorded.

Surgical Technique

The endoscopic equipment in terms of optic, monitor, gas supply, suction device, graspers, monopolar hook, and endobag were equal in both groups. The minimum individual surgeons experience in LC required to operate on study patients was 10 SPLC and 30 4PLC, respectively. Study surgeons were required to participate in a 1-day SPLC workshop. For patients undergoing SPLC a 10 mm atraumatic access device was used (SILSTM PT12; Covidien Inc., Norwalk, CT). Exposure of the gallbladder was achieved through an intra-abdominal anchored retraction device (EndoGrabTM; Virtual Ports Ltd., Caesarea, Israel) that was introduced and placed at the fundus and the parietal peritoneum. Exposure of the triangle of Calot and lateral retraction of the gallbladder infundibulum was performed using a bending grasper (Endograsp roticulatorTM, Covidien Inc., Norwalk, CT). A detailed description of the surgical technique for SPLC and 4PLC was described in the publication of the study protocol.[11]

RESULTS

Patient Flow

Figure 1 illustrates the patient flow according to the CONSORT guidelines.[10,22,23] Of the 132 patients, assessed for eligibility, 110 were randomized. Seventy percent of the patients were treated at the University Hospital Zurich, and 30% at the Cantonal Hospital Winterthur. Fifty-five patients were randomized to single-port cholecystectomy (SPLC) and 55 to conventional 4-port cholecystectomy (4PLC). Four patients from the SPLC-group and 3 patients from the 4PLC-group were lost in follow-up within the first postoperative week. In all 7 cases, the patients did not revisit the outpatient clinic despite reminder letters and direct phone calls to the patients. Another 3 patients from the SPLC-group and 4 patients from the 4PLC-group were excluded after randomization because of either patient study consent withdrawal after surgery or incorrect study inclusion due to faulty inclusion criteria. Finally, 48 patients in each group were analyzed in this study

Baseline Patient Characteristics

Ninety-six patients [64 women, mean age 46 (SD: 14 years)] were randomly allocated to SPLC (n = 48) and 4PLC (n = 48). Table 1 lists the patients' characteristics. Age, sex, body mass index, history of previous abdominal surgery, and other comorbidities were equally distributed in both groups. There were no statistically significant differences among the parameters.

Perioperative Characteristics

The mean operation duration was longer in SPLC when compared to the conventional 4PLC (mean 101 vs 90 minutes, $P = 0.031$, Table 1). One patient in each group was converted to open cholecystectomy. Additional trocars were used in 4 patients with SPLC. There were no significant differences in intraoperative complication rates, even though, the surgeons ''comfort with the operation'' was higher in the 4PLC-group ($P = 0.002$, Table 1).

Cosmesis and Body Image Score After 12 Weeks and 1 Year

As shown in Table 2 the SPLC-group showed a superior median cosmesis score when compared with the 4PLC-group after

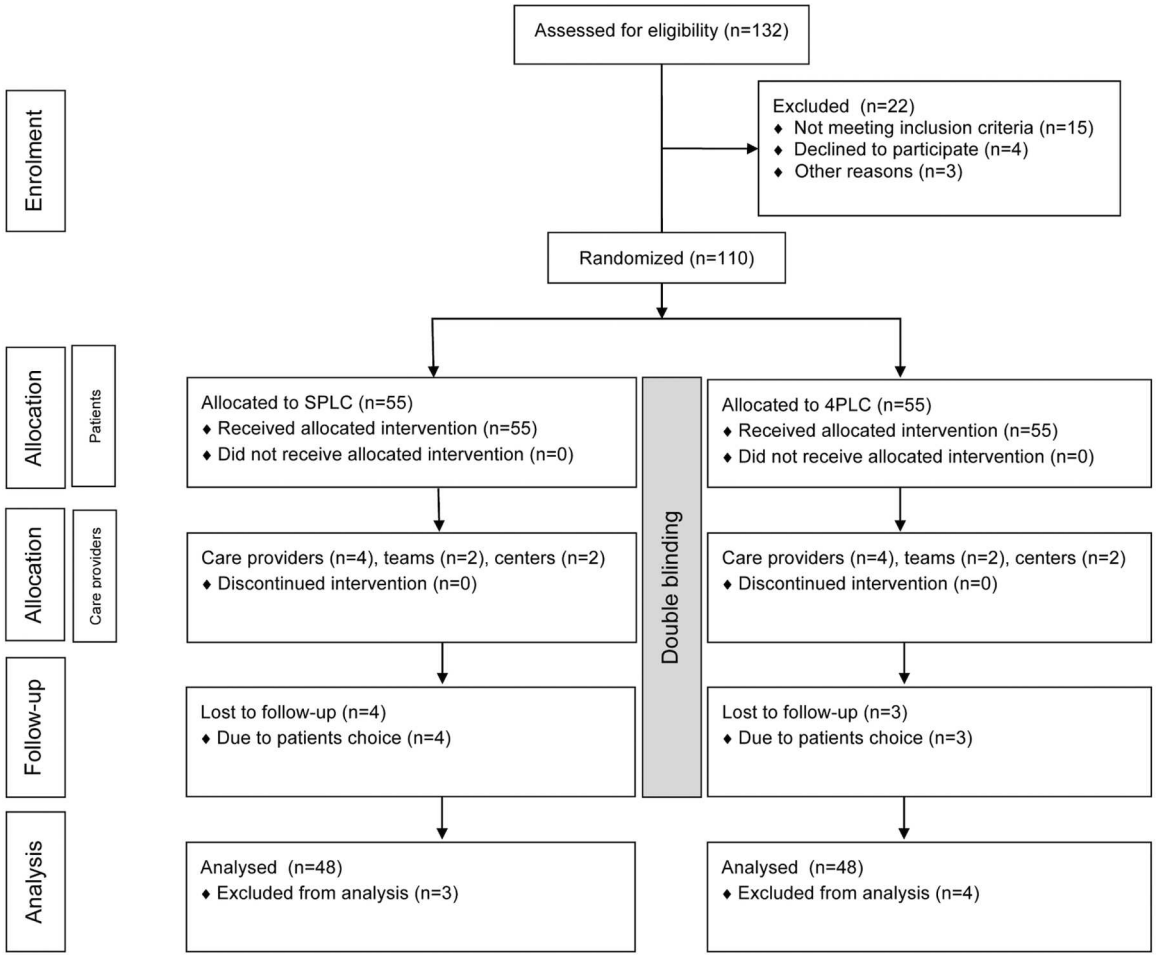

FIGURE 1. CONSORT NPT study flow diagram. Adopted from Boutron et al.[10]

12 weeks (21 vs 16, $P < 0.001$) and after 1 year (24 vs 16, $P < 0.001$, respectively). Similarly, the body image score was superior at the 12-week and 1-year follow-up for the SPLC-group when compared with the 4PLC-group (5 vs 6, $P = 0.013$, 5 vs 6, $P = 0.017$, respectively) (Table 2).

Postoperative Pain and Analgesic Requirements

Postoperative pain was lower after SPLC compared with 4PLC on postoperative day 2 [1.0 (SD 1.0) vs 2.0 (SD 2.0), $P < 0.001$] and day 7 [1.0 (SD 1.0) vs 2.0 (SD 2.0), $P < 0.005$] (Table 2). In addition, nonopioid analgesic requirements were significantly lower in the SPLC-group when compared with the 4PLC-group (Table 2).

Postoperative Surgical Complications and Length of Hospital Stay

With 20% overall complications (Clavien-Dindo, I-V) after SPLC and 27% after 4PLC, postoperative complication rates were not different between the groups ($P = 0.642$, Table 3). The mean Comprehensive Complication Index (CCI) of the highest complication grade was low and similar [mean 3.2 (7.3) for SPLC and 2.5 (5.1) for 4PLC, $P = 0.855$, CCI: min 0, max 100] between the groups. Clavien-Dindo IIIa complications occurred in 3 patients after SPLC (2 ERCPs and 1 chest drain), and in 1 patient after 4PLC (ERCP). The median hospital stay was similar in both groups (Table 3). There were 2 umbilical hernias in the SPLC group, compared with no incisional hernia in patients undergoing 4PLC at 12-month follow-up. From these 2 SPLC hernias, 1 patient was unknowingly pregnant during her SPLC-procedure and developed an incisional hernia 4 months after surgery during pregnancy. This difference did not reach statistical significance (Table 2). In addition, 1 SPLC patient with a medical history of smoking, chronic obstructive pulmonary disease, and primary spontaneous pneumothorax developed a spontaneous pneumothorax postoperatively that required interventional chest-tube placement.

Quality of Life (SF-36)

Quality of life 12 weeks postoperatively, as assessed by the SF-36 score, was similar in both groups (Table 4). However, after 1 year, QoL was significantly higher in the SPLC-group compared with 4PLC-group with regard to emotional wellbeing, physical pain, physical health, and mental health (Table 4).

Scar Length and Width

At 1-year follow-up, the mean scar length was 21 (SD 24) versus 42 mm (SD 22) for the SPLC and 4PLC groups, respectively

TABLE 1. Patient and Operative Characteristics

Characteristics	All Patients (n = 96)	4PLC (n = 48)	SPLC (n = 48)	OR (95% CI)	*P*
Patient					
Age (y), mean (SD)	46 (14)	44 (13)	48 (16)	–	0.221
Sex, female/male, n	34/62	29/19	33/15	0.69 (0.30–1.61)	0.522
BMI (kg/m^2) mean (SD)	25 (4)	26 (5)	25 (3)	–	0.109
ASA grade I-II/III, n	68/37/1	31/17/0	37/10/1	–	0.188
Disease, yes/no, n					
Cholecystolithiasis	57	26	31	–	0.284*
Acute cholecystitis	29	17	12	–	–
Gallstone pancreatitis	2	0	2	–	–
Other	8	5	3	–	–
Comorbidities, yes, n					
Cardiovascular	12	6	6	1.00 (0.30–3.35)	1.000
Respiratory	3	1	2	0.49 (0.04–5.58)	1.000
Neurological	6	3	3	1.00 (0.19–5.22)	1.000
Endocrine	9	4	5	0.78 (0.20–3.11)	1.000
Other	14	6	8	0.71 (0.23–2.24)	0.733
Previous abdominal surgery, n operative	31	16	15	1.10 (0.47–2.59)	1.000
Operation duration (minutes), mean, (SD)	95 (39)	90 (41)	101 (36)	–	0.031
Cystic artery identified, yes/no, n	88/8	43/5	45/3	0.57 (0.13–2.55)	0.714
Gallbladder perforation, yes/no, n	15/81	8/40	7/41	1.17 (0.39–3.53)	1.000
Cholangiography,† yes/no, n	3/93	1/47	2/46	0.49 (0.04–5.59)	1.000
Conversion,‡ yes/no, n	2/94	1/47	1/47	1.00 (0.06–16.46)	1.000
Additional trocar, yes/no, n	4/92	0/48	4/44	–	0.117
Intraoperative complication, yes/no, n	3/93	3/45	0/48	–	0.242
Bleeding,§ yes, n	2	2/46	0/48	–	0.495
Bile duct injury, yes, n	0	0/48	0/48	–	–
Surgeon comfort with operation¶ yes/no, n	83/13	47/1	36/12	15.67 (1.95–126.12)	0.002

*Pearson χ^2, refers to all disease types.
†Intraoperative cholangiography performed.
‡4PLC or SPLC to open cholecystectomy.
§Intraoperative bleeding limited with coagulation and/or clips without requiring any blood transfusion.
¶Surgeon's subjective assessment of comfort with operation.
ASA indicates American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval; OR, odds ratio.

($P < 0.001$). Similarly, the mean scar width was 2 (SD 1) in the SPLC-group and 3 mm (SD 3) in patients undergoing 4PLC ($P < 0.001$).

DISCUSSION

This is the first double-blinded randomized controlled trial comparing single port laparoscopic cholecystectomy (SPLC) with 4-port laparoscopic cholecystectomy (4PLC). Beneficial effects of SPLC are not only related to an improved postoperative pain profile, but also to better cosmesis and body image.

In an attempt to further reduce the invasiveness of LC, new operative techniques, such as SPLC, were introduced.[8] Most attention in assessing its clinical usefulness focused on safety and postoperative pain. Interestingly, very little has been done to assess the short- and long-term cosmetic benefit for the patient, although, this aspect was highly promoted by the industry. Furthermore, it was highlighted in a recent meta-analysis by the Cochrane Hepato-Biliary Group that the methodological quality of current studies is too low to currently support SPLC as the standard of care in patients with benign gallbladder disease.[9] In contrast to previously published studies, the present trial includes a double-blinded design and a complete follow-up after 1 year.

This study revealed several important findings. First, superior short- and long-term cosmesis and body image were the most significant factors associated with the use of SPLC compared with patients undergoing conventional 4PLC. Cosmesis is a significant factor especially in younger patients and those with benign conditions undergoing surgical procedures.[24] As such, Dunker et al[12] used scaled questionnaires with a single composite score to assess open versus laparoscopic ileocolic resection for Crohn disease with regard to differences in cosmetic satisfaction and body image perception. These are considered patient reported outcomes assessing the patients' perception of their body and their attitude towards their appearance and the degree of patient satisfaction with respect to the appearance of their scars.[12] Cosmesis and body image as a primary endpoint was considered in only 1 SPLC trial, although follow-up time (1 month) to properly assess cosmesis and body image was too short to draw reliable conclusions.[9,25] In the present trial, cosmesis and body image were higher in the SPLC cohort compared with the 4PLC-group 12 weeks and 1 year after surgery, typically when a surgical scar is expected to have healed completely. This is of particular interest as the cosmetic benefit for the patient is the main attraction of SPLC.

Several factors affect intrinsic and extrinsic postoperative pain, such as incision, bile leakage, intraperitoneal pressure, use of local anesthetics, peritoneal lavage, and psychological factors. However, it is well known that the length of incision is the most important determinant for sensation of pain.[9,26–28] Even though there is some evidence that postoperative pain may be less in patients undergoing SPLC compared with 4PLC,[9,25,29] none of these trials was blinded with regard to the incisions for patients, treating physicians, and nurses as suggested in a critical letter from the Heidelberg group.[30] In the present double-blinded trial, postoperative pain, assessed by the VAS, was significantly lower in the SPLC-group reflecting less use of paracetamol and metamizole compared with patients undergoing conventional 4PLC. This positive effect of

TABLE 2. Cosmesis, Body Image, Pain Assessed by the Visual Analogue Scale, Analgesic Use, and Work Leave

Parameters	All Patients (n = 96)	4PLC (n = 48)	SPLC (n = 48)	*P*
Preoperative				
Body image score,* median (IQR)	1 (1–1)	1 (1–1)	1 (1–1)	0.607
Pain VAS, mean (SD)	2.0 (2.2)	1.9 (2.3)	2.1 (2.1)	0.527
Analgesic use,† n yes/no	12/86	3/45	9/39	0.120
Nausea/bloating score, median (IQR)	2 (1–3)	3 (1–3.5)	2 (1–3)	0.154
Operation day*				
Pain VAS	3.4 (1.8)	4.0 (2.0)	3.0 (1.0)	0.347
Paracetamol, g/d, mean (SD)§	3.1 (1.4)	3.4 (1.3)	2.9 (1.4)	0.043
Metamizole, g/day, mean (SD)‡	2.5 (1.7)	2.7 (1.6)	2.3 (1.8)	0.289
Postoperative day 1				
Pain VAS	2.8 (1.8)	3.0 (2.0)	2.6 (2.0)	0.130
Paracetamol, g/d, mean (SD)	2.6 (1.7)	3.2 (1.4)	2.0 (1.8)	0.002
Metamizole, g/d, mean (SD)	2.2 (1.8)	2.7 (1.7)	1.7 (1.8)	0.020
Postoperative day 2				
Pain VAS	1.7 (1.5)	2.0 (2.0)	1.0 (1.0)	0.001
Paracetamol, g/d, mean (SD)	2.6 (1.7)	2.8 (1.8)	1.4 (1.7)	0.009
Metamizole, g/d, mean (SD)	2.2 (1.8)	2.5 (1.7)	1 (1.6)	0.005
Postoperative day 7 (outpatient)				
Pain VAS	1.9 (1.6)	2.0 (2.0)	1.0 (1.0)	0.005
Nausea/bloating score, median (IQR)	1 (1–2)	1 (1–2)	1 (1–2)	0.444
12 weeks postoperative				
Cosmesis score,* median (IQR)	19 (14–21)	16 (13–19)	21 (19–23)	<0.001
Body image score,* median (IQR)	5 (5–6)	6 (5–7)	5 (5–5)	0.013
Pain VAS	0.8 (0.2)	0.9 (0.2)	0.8 (0.2)	0.558
Nausea/bloating	1 (1–2)	1 (1–2)	1 (1–2)	0.859
1-year postoperative				
Cosmesis score,* median (IQR)	21 (15–24)	16 (13–20)	24 (22–24)	<0.001
Body image score,* median (IQR)	5 (5–5)	6 (5–7)	5 (5–5)	0.017
Pain VAS	0.9 (0.2)	0.9 (0.2)	0.9 (0.2)	0.067
Nausea/bloating score, median (IQR)	1 (1–2)	1 (1–2)	1 (1–1)	0.010
Work leave, mean total days (SD)	10 (5)	11 (5)	9 (4)	0.050
Umbilical hernia	2	0	2	0.495

Cosmesis score (between 3 and 24, with a high score meaning better cosmetic results). Body image score (between 5 and 20, with a low score meaning a better body image).
*Operation day indicates immediately postoperative at the ward.
†Refers to any type of analgesics.
‡Metamizole manufactured under the common brand Novalgin (Sanofi-Aventis SA, Vernier, Switzerland).
§Paracetamol manufactured under the common brand Dafalgan (Bristol-Myers Squibb SA, Cham, Switzerland).
CI indicates confidence interval; IQR, interquartile range; VAS, visual analogue scale (0 is no pain, whereas 10 is excruciating pain).

SPLC on pain, noted in the early postoperative phase, might explain the shorter leave of absence from work in the present collectives, whereas 12 weeks and 1 year after the procedure no differences were noted with regard to pain sensation.

Quality of Life has become an important outcome criteria in single-incision laparoscopic surgery and the disease and its treatment may have an impact not only on clinical outcome, but also on the well-being of the individual.[31] Although there are currently over 800 different instruments that measure health-related QoL, the most accepted and validated health profile is the short-form 36 (SF-36).[19] Ma et al evaluated QoL earlier but were unable to detect any difference between the SPLC and 4PLC- group.[32] As stated by the authors, their trial was not designed to evaluate the differences in long-term QoL between SPLC and 4PLC, which would be an interesting point to address in future studies. The present trial is the first study assessing long-term QoL with the validated SF-36, showing the positive impact of SPLC 1 year after surgery for both mental and physical health. This difference was mainly attributed to the superior emotional well-being and physical pain favoring the SPLC-group. We interpret this difference based on the personal body image and sense of attractiveness offered by SPLC coupled by less scarring and improved cosmesis.

The operating time was 11 minutes longer in the SPLC-group compared with the 4PLC-group reflecting a technically more demanding procedure with a certain learning curve. SPLC, however, proved to be safe as no differences in surgical complications were noted between both arms. Nevertheless, in 25% of the SPLC cases (12 out of 48 operations) surgeons complained about discomfort, which was significantly higher than in 4PLC cases (2%, 1 out of 48). This lack of surgeon's confidence might be an important reason why SPLC has not found wide acceptance until now. In the present trial, there were no differences in surgical complications between the 4PLC and SPLC study arm. A lack of surgeon's confidence, howeve,r as noted in SPLC may still influence the rate of complications, especially the most dangerous and rare ones, such as bile duct injuries. Even though a recent meta-analysis of 11 RCTs[33] did not show any significant difference in overall biliary complications and bile duct injuries in patients undergoing SPLC, further well-designed high volume trials are needed to make final conclusions. Another reason preventing the implementation of single port technique in many institutions could be cost related. In addition to the prolonged operating time, single-use materials, such as the single port system, the curved single port grasper, and the endocavity retractor, are required and thus increase economic consumption. Potential compensatory economic effects of a faster time return to work of SPLC remain questionable.

Some limitations to this trial need to be declared. Firstly, within the 3-year time frame of the study, a series of patients in

TABLE 3. Postoperative Complications and Hospital Stay

Characteristics	All Patients (n = 96)	4PLC (n = 48)	SPLC (n = 48)	OR (95% CI)	*P*
Any complication, yes/no, n	23/73	13	10	1.3 (0.52–3.3)	0.642
Clavien-Dindo Complication Grade, n					
No complications	73	35	38	–	0.379
Grade I	16	10	6	–	–
Grade II	1	0	1	–	–
Grade IIIa	4	1	3	–	–
CCI of the highest complication, mean (SD)	2.8 (6.3)	2.5 (5.1)	3.2 (7.3)	–	0.855
Complication type*†					
Self-limited bleeding‡	3	2	1	2.1 (0.2–23.8)	0.617
Nausea	14	9	5	2.3 (0.6–6.6)	0.261
Wound infection	3	1	2	0.5 (0.4–5.7)	1.000
Retained bile duct stones	3	1	2	0.5 (0.4–5.7)	1.000
Pneumothorax	1	0	1	–	0.390
Urinary retention	1	0	1	–	0.390
ERCP postoperative	2	1	2	–	0.495
Chest drainage under LA	1	0	1	–	1.000
Hospital stay in days, median (IQR)	2 (2–3)	2 (2–3)	2 (2–3)	–	0.720

*According to the Clavien-Dindo complication score.
†No injuries to bowel, bile duct, and other hilar vascular structures.
‡Postoperative self-limited bleeding without any blood transfusion administered.
ERCP indicates endoscopic retrograde cholangiopancreatography; IQR, interquartile range; OR, odds ratio; LA, local anesthesia; VAS, visual analogue scale (0 is no pain, whereas 10 is excruciating pain).

TABLE 4. Quality of Life as Assessed by SF-36

Parameters, mean % (SD)	All Patients (n = 96)	4PLC (n = 48)	SPLC (n = 48)	*P*
Preoperative				
Physical activity	87 (19)	87 (20)	86 (20)	0.375
Role limitations due to physical health	79 (36)	74 (39)	81 (33)	0.954
Role limitations due to emotional problems	82 (32)	81 (34)	81 (32)	0.818
Energy/fatigue	62 (20)	62 (21)	60 (19)	0.554
Emotional well being	74 (16)	73 (17)	75 (15)	0.640
Social functioning	83 (23)	80 (24)	85 (22)	0.378
Pain	65 (29)	61 (31)	65 (28)	0.982
General health	69 (18)	69 (18)	67 (17)	0.828
Physical health	83 (18)	83 (19)	83 (17)	0.722
Mental health	80 (18)	81 (19)	79 (17)	0.889
12 weeks postoperative				
Physical activity	92 (18)	91 (21)	91 (16)	0.800
Role limitations due to physical health	91 (25)	90 (27)	91 (26)	0.742
Role limitations due to emotional problems	87 (30)	87 (32)	88 (29)	0.873
Energy/fatigue	68 (20)	67 (20)	67 (20)	0.695
Emotional well being	78 (17)	77 (17)	79 (18)	0.461
Social functioning	90 (18)	89 (20)	92 (15)	0.319
Pain	86 (22)	87 (20)	84 (25)	0.558
General health	75 (20)	74 (29)	74 (22)	0.657
Physical health	86 (17)	86 (17)	86 (18)	0.343
Mental health	81 (17)	80 (19)	82 (16)	0.375
1 year postoperative				
Physical activity	93 (19)	90 (24)	95 (13)	0.196
Role limitations due to physical health	91 (26)	90 (27)	92 (26)	0.373
Role limitations due to emotional problems	92 (26)	87 (33)	96 (16)	0.152
Energy/fatigue	70 (20)	66 (20)	74 (19)	0.051
Emotional well being	81 (15)	77 (16)	85 (13)	0.015
Social functioning	91 (18)	87 (23)	94 (13)	0.223
Pain	91 (18)	90 (18)	92 (19)	0.047
General health	77 (19)	74 (18)	81 (19)	0.046
Physical health	88 (15)	86 (16)	90 (14)	0.034
Mental health	83 (17)	79 (20)	87 (11)	0.032

both participating hospitals were not assessed for eligibility. This was caused not only by the limited availability of surgeons performing SPLC for the study, but also because of relatively low recruiting rates for the study. This effect is well known in surgical studies and has been described previously in detail.[34,35] A second limitation represents the integration of several surgeons from 2 different centers performing the operations. It is known that individual surgical attributes lead to variability in practice and health outcomes. However, the involvement of multiple surgeons, represent daily practice in gallbladder surgery, which was a target in the present clinical trial.

To conclude, while there were no differences in surgical complications and length of hospital stay, the advantages of SPLC mainly relate to improved short- and long-term cosmesis, body image, and QoL with a favorable postoperative pain profile and quicker return to work compared with patients undergoing 4PLC. Although cost-effectiveness is still a subject of ongoing debate that needs to be assessed in future clinical trials, SPLC should be offered to patients undergoing surgery for benign gallbladder disease.

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DISCUSSANTS

M. Krawczyk (Warsaw, Poland):

First of all I would like to thank ESA for giving me the privilege to be the first discussant on this excellent study. I would like to congratulate the authors on preparing the study on a very topical subject concerningLC. Although my first reaction when I had read the manuscript was that even the surgeons with little experience in surgery know, without referring to any study, that 1 incision causes less pain than 4 incisions and that 1 incision from the cosmesis point of view is better than 4. I must admit that the strong side of the study is the methodology. Congratulations!

Allow me now to present my questions. Firstly, why have you decided that endpoint in cosmesis is a 20% improvement, especially that you used the body image questionnaire, which ranges from 8 to 44 points? My second question concerns the incisional hernia. You found 2 umbilical hernias in a single-port operation. I presume that in reality it is more important than a positive effect on cosmesis in the

remaining patients in the group. Could you comment on this problem? The third question concerns the training of the surgeon. The 4 trocars LC is a common operation mastered by most surgeons, whereas single trocar is a much more difficult procedure. You did not mention that it is necessary to have extra training and that it makes the operation more expensive.

Response From G. Lurje (Aachen, Germany):

Thank you, professor Krawczyk, for your comments. I will try to answer them point-by-point. Your first comment addressed power calculations and cut-off of our primary endpoints for cosmesis and body image. We estimated our sample size calculation by using available data at the time of the trial design. In clinical trials, a 20% improvement in outcome is generally regarded as significant. We made an arbitrary estimation at the time of the trial design, as no other studies were available evaluating cosmesis and body image in SPLC. With regards to your second question, incisional hernias are obviously a frustrating issue, especially in single-port surgery. We had 2 hernias in our study cohort. One of these patients was unknowingly pregnant during the time of the operation, and she developed an incisional hernia during pregnancy. Nevertheless, this study was not designed to address this topic appropriately, and this may require further analyses.

In response to your final comment, cost-effectiveness in healthcare and medical training has always been key concerns. SPLC is clearly a more demanding surgical procedure compared with the conventional 4-port cholecystectomy. Costs are generally believed to be higher in SPLC due to the comparatively expensive instruments needed for the procedure. Nonetheless, reliable predictions regarding costs cannot be made at this stage as cost-effectiveness is influenced by various factors, such as return to work after surgery. We are planning to perform a comprehensive cost effectiveness analysis for the future.

N. Senninger (Münster, Germany):

I enjoyed your presentation. However, I have some remarks. First of all, at the German Surgical Congress just 10 days ago, we discussed the same matter; and the opinion was that single-port is not superior, if at all equal in a selected group of patients. Secondly, if there were complications, they were usually more severe. The incisional hernia and the secondary healings around an umbilicus were much more severe in single-port surgery than after conventional laparoscopic operations. You gave us the grade 3A complications according to Clavien-Dindo. There were 3 in the single-port versus none in the conventional laparoscopic group, which is relevant although in your study not significant because the numbers are too small. I do not believe that you really can double-blind a study like this. Even if you put dressings on the abdominal wound on 4 places the patient will realize that there is no incision underneath. This makes me ask whether the patients were influenced towards a positive opinion in the SILS-group.

Response From G. Lurje (Aachen, Germany):

Thank you Professor Senninger for your comments. With regards to your first remark, I am not sure what kind of studies were discussed at the German Surgical Meeting. Nevertheless, a recent meta-analysis of 7 randomized controlled trials (RCT) comprising 855 patients by the Cochrane Hepato-biliary Group did not show significant differences in surgical complications between SPLC and conventional 4-port cholecystectomy. Despite the fact that surgical complications were not the primary endpoint of our study, we did not observe any statistical differences either. The primary endpoint of this present study was cosmesis and body image. Our trial is not powered to draw final conclusions on incisional hernias, even though we did not observe any significant differences in our cohort.

In response to your comments on the legitimacy of double-blinding, I agree with you that this is a difficult task. Double-blinding was essentially used for the assessment of postoperative pain, and we did not detect that the patients could be aware of the group they belong to. Thus, we believe that patients were not influenced towards a positive opinion for one or the other study-arm.

W.A. Bemelman (Amsterdam, The Netherlands):

I am glad to see that you still use the body image and cosmesis questionnaires that we developed almost more than 20 years ago. We have had difficulties finding differences in body image in patients with inflammatory bowel disease (IBD) comparing midline laparotomy with Pfannenstiel incisions or midline laparotomy with port sites. So why is your effect you found so big? It is a relatively significant effect for let us say a small difference in scars.

Response From G. Lurje (Aachen, Germany):

Thank you Professor Bemelman for your comments. We found your cosmesis questionnaires to be quite appropriate for this type of study design. In this age of scarless and minimal invasive surgery, the patient's expectations from surgical procedures have increased. We therefore assume that the significance of the relatively small difference in scarring has also increased.

W.A. Bemelman (Amsterdam, The Netherlands):

I have a short second question. Was there a difference between men and women? Men, like women, care about cosmesis, but unlike women they are less affected considering body image.

Response From G. Lurje (Aachen, Germany):

Thank you very much for raising this interesting point about possible sex differences, but we did not observe any sex-related discrepancies, although the study was not designed to answer this question.